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CHAPTER FIFTY-ONE

SPECIAL DESIGN ELEMENTS

51-1.0 ACCESSIBILITY FOR HANDICAPPED INDIVIDUALS

Many highway elements can affect the accessibility and mobility of handicapped individuals. These include sidewalks, parking lots, buildings at transportation facilities, overpasses and underpasses. The Department's accessibility criteria complies with the 1990 *Americans with Disabilities Act* (ADA). The following sections present accessibility criteria which are based on information presented in the *ADA Accessibility Guidelines for Buildings and Facilities* (ADA Guidelines). Designers are required to meet the criteria presented in the following sections. When other agencies or local codes require standards which exceed the *ADA Guidelines*, then the stricter criteria may be required. This will be determined on a case-by-case basis.

51-1.01 Buildings

For interior accessibility criteria, the following will apply:

1. New. All new buildings, airport terminals, rest areas, weigh stations and transit stations (e.g., stations for rapid rail, light rail, commuter rail, intercity bus, intercity rail, high-speed rail and other fixed guideway systems) shall meet the accessibility criteria set forth in the *ADA Guidelines*. The designer should review the *ADA Guidelines* to determine the appropriate accessibility requirements for building interiors, including rest rooms, drinking fountains, elevators, telephones, etc.

2. Existing. In general, for alterations made to existing buildings or facilities, the designer must meet the accessibility requirements for the alteration made to the facility, unless it is prohibitively expensive to do so. The designer should review the *ADA Guidelines* to determine the appropriate criteria and, if required, where exceptions may be allowed.

51-1.02 Bus Stops

The following accessibility criteria apply to the construction of bus stops:

1. Bus Stop Pads. New bus stop pads constructed to be used in conjunction with a lift or ramp shall meet the following criteria:

a. A firm stable surface must be provided.

b. It must have a minimum clear length of 2440 mm (measured from the curb or roadway edge) and minimum clear width of 1525 mm (measured parallel to the roadway) depending on the legal or site constraints.

c. It must be connected to streets, sidewalks or pedestrian paths by at least one accessible route.

d. The slope of pad parallel to the roadway must be the same as the roadway to the maximum extent practical.

e. For drainage purposes, a maximum cross slope of 2% perpendicular to the roadway is allowable.

2. Bus Shelters. Where new or replaced bus shelters are provided, they must be installed or positioned to permit a wheelchair user to enter from the public way and reach a location within the shelter having a minimum clear floor area of 760 mm by 1220 mm. An accessible route shall be provided from the shelter to the boarding area.

3. Signage. All new bus route identification signs should be sized based on the maximum dimensions permitted by local, state or federal regulations or ordinances. The signs shall have an eggshell, matte or other non-glare finish. The characters or symbols shall contrast with their background (i.e., light characters on a dark background or dark characters on a light background).

51-1.03 Parking

51-1.03(01) Off-Street Parking

The following criteria apply to off-street handicapped parking spaces:

1. Minimum Number. Figure 51-1A, Minimum Number of Accessible Spaces for Handicapped Users provides this criteria. A typical handicapped-user stall layout is shown in Figure 51-1B.
One out of every eight accessible spaces, but not less than one, shall have an access aisle 2440-mm wide and must be designated as van accessible.

2. Location. Parking spaces for disabled individuals and accessible passenger loading zones

that serve a particular building shall be the spaces or zones closest to the nearest accessible entrance on an accessible route. In separate parking structures or lots that do not serve a particular building, parking spaces for disabled individuals shall be located on the shortest possible circulation route to an accessible pedestrian entrance of the parking facility. In buildings with multiple access entrances with adjacent parking, accessible parking spaces shall be dispersed and located closest to the accessible entrances.

3. Signing. Parking spaces for the handicapped shall be designated by above-grade signs with white lettering against a blue background and shall bear the international symbol of access (see the MUTCD). The sign shall not be obscured by a vehicle parked in the space. Van-accessible spaces shall have a supplemental "Van Accessible" sign below the symbol of accessibility.
4. Dimensions. The parking spaces designated for the handicapped shall be at a minimum 2440-mm wide and desirably 2750-mm wide with an additional 1525-mm minimum access aisle or 2440-mm next to van-accessible spaces, or the space should be parallel to a sidewalk on a public highway (see Figure 51-1B). Parking access aisles shall be part of an accessible route to the building or facility entrance. Parked vehicular overhangs shall not reduce the clear width of an accessible circulation route. Parking spaces and access aisles shall be level with surface slopes not exceeding 2% in all directions. Any parking garage or terminal should have a 2895-mm vertical clearance at its entrance, exit and along the route to and from at least two parking spaces which have a 2895-mm vertical clearance.

5. Passenger Loading Zones. Passenger loading zones shall provide an access aisle at least 1.5 m wide and 6.0 m long adjacent and parallel to the vehicular pull-up space. If there are curbs between the access aisle and the vehicular pull-up space, then a curb ramp complying with Section 51-1.08 shall be provided. Vehicular standing spaces and access aisles shall be essentially level. Surface slopes shall not exceed 2% in all directions.

51-1.03(02) On-Street Parking

Where new on-street paid or time-limited parking is provided and designated in districts zoned for business uses, the on-street parking design shall meet the following accessibility criteria:

1. Minimum Number. Figure 51-1A provides the criteria for the minimum number of on-street accessibility spaces.

2. Location. On-street accessibility parking spaces will be dispersed throughout the project area. To the maximum extent feasible, accessible on-street parking should be located in level areas.
3. Dimensions. At a minimum, a 2.4-m wide parking space with a 1.5 m access isle must be provided. This is illustrated in Figure 51-1C, Handicapped Parking (On-Street Parking).

The travel lane shall not encroach into the access aisle.

4. Signage. Parking spaces for the handicapped shall be designated by above-ground signs with white lettering against a blue background, and the signs shall bear the international symbol of access (see the MUTCD). These signs will be located to be visible from a driver's seat.
5. Curb Ramps. If there are curbs next to an on-street accessible parking space, then a curb ramp complying with Section 51-1.08 shall be provided. Access parking spaces adjacent to intersections may be served by the sidewalk curb ramp at the intersection, provided that the path of travel from the access aisle to the curb ramp is within the pedestrian crossing area.

6. Parking Meters. Where provided, parking meter controls shall be a maximum of 1065 mm above the sidewalk or pedestrian circulation path and within 225 mm horizontally of, and centered on the clear ground space for a parallel approach or abut and be centered on the clear ground space for a forward approach. Controls and operating mechanisms shall be operable with one hand and shall not require tight grasping, pinching or twisting of the wrist. The force required to activate controls shall be no greater than 22.2 N. A firm, stable and slip-resistant area (760 mm by 1220 mm), with the least possible slope, shall be provided at the controls and shall be connected to the sidewalk by a continuous passage that is a minimum of 915-mm wide. Parking meters should be located at or near the head or foot of the parking space so there is no interference with the operation of a vehicle side lift or a passenger side transfer.

51-1.04 Accessible Route

An accessible route is a continuous, unobstructed path connecting all accessible elements and spaces in a building, facility or site. A “site” is defined as a parcel of land bounded by a property line or a designated portion of a public right-of-way. A “facility” is defined as all or any portion of buildings, structures, site improvements, complexes, equipment, roads, walks, passageways, parking lots, or other real or personal property on a site. Interior accessible routes may include corridors, floors, ramps, elevators, lifts and clear floor space at fixtures. Exterior accessible routes may include parking access aisles, curb ramps, crosswalks at vehicular ways, walks, ramps and lifts.

Accessible routes must be provided as follows:

1. At least one accessible route within the boundary of the site shall be provided from public transportation stops, accessible parking, accessible passenger loading zones, and public streets or sidewalks to the accessible building entrance they serve. The accessible route shall, to the maximum extent feasible, coincide with the route for the general public.

2. At least one accessible route shall connect accessible buildings, facilities, elements, and

spaces that are on the same site.

3. At least one accessible route shall connect accessible buildings or facility entrances with all accessible spaces and elements and with all accessible dwelling units within the building or facility.

For highway projects, the application of the accessible route criteria applies to definitive sites which are related to highway purposes. These include rest areas, recreational areas, park-and-ride lots, etc. Section 51-1.05 provides the accessibility requirements for sidewalks.

51-1.05 Sidewalks

Section 45-1.06 presents the Department's warrants and design criteria for sidewalks. In addition, all sidewalks must comply with the *ADA Guidelines* presented in the following sections.

51-1.05(01) Criteria for Sidewalks on Accessible Routes

For sidewalks on accessible routes, the following accessibility criteria shall be met:

1. Width. The minimum clear width shall be 900 mm, except at doors which may have a minimum width of 800 mm.

2. Passing Space. If the sidewalk has less than 1.5-m clear width, then passing spaces at least 1.5 m by 1.5 m shall be located at reasonable intervals not to exceed 60 m. A T-intersection between two walks is an acceptable passing space.

3. Surface. All sidewalk surfaces shall be stable, firm and slip resistant. The longitudinal gradient should be flush and free of abrupt changes. However, changes in level up to 6 mm may be vertical and without edge treatment. Changes in level between 6 mm and 13 mm shall be beveled with a slope no greater than 50%. Changes greater than 13 mm shall be accommodated with a ramp (see Section 51-1.07).

   Gratings should not be placed within the walking surface. If, however, gratings are located in walking surfaces, then they shall have spaces no greater than 13-mm wide in one direction. If gratings have elongated openings, then they shall be placed so that the long dimension is perpendicular to the dominant direction of travel.

4. Slope. The sidewalk cross slope shall not exceed 2%. If the longitudinal gradient exceeds

5%, the sidewalk must meet the accessibility criteria for ramps (see Section 51-1.07).

5. Protruding Objects. Objects projecting from walls (e.g., signs, telephones, canopies) with their leading edges between 0.7 m and 2.0 m above the finished sidewalk shall not protrude more than 100 mm into any portion of the sidewalk. Freestanding objects mounted on posts or pylons may overhang their mountings up to a maximum of 300 mm when located between 0.7 m and 2.0 m above the sidewalk or ground surface. Protruding objects less than 0.7 m or greater than 2.0 m may protrude any amount provided that the effective width of the sidewalk is maintained. Where the vertical clearance is less than 2.0 m, a barrier shall be provided to warn the blind or visually-impaired person.

6. Separation. Sidewalks will be separated from roadways by curbs, planted parkways or other barriers, which will be continuous except where interrupted by driveways, alleys or connections to accessible elements.

7. Bus Stops. Where bus passenger loading areas or bus shelters are provided on or adjacent to sidewalks, they must comply with the criteria in Section 51-1.02.

8. Curb Ramps. All curb ramps on an accessible route must comply with the criteria in Section 51-1.08.

51-1.05(02) Criteria for Sidewalks on Public Right-of-Way

All sidewalks on public R/W that are not part of an accessible route should meet the criteria presented in Section 51-1.05(01). However, the *ADA Guidelines* provide some flexibility to meet the adjacent roadway conditions and to provide practical designs. The criteria in Section 51-1.05(01) shall be implemented, unless noted as follows:

1. Slopes. The flattest longitudinal slope practical should be provided. Preferably, the longitudinal slope should not exceed 8.3% (12:1) or the longitudinal slope of the adjacent street. Sidewalk slopes 5% or greater do not require the use of handrails as defined in Section 51-1.07.

2. Separation. Sidewalks adjacent to the curb or roadway may be offset to avoid a non-conforming cross slope at driveway aprons by diverting the sidewalk around the apron.

3. Street Furniture. Street furniture such as signal controller cabinets, light standards, strain poles, utility poles, mailboxes, sign supports, etc., should not be placed within the required sidewalk width. In those locations where it is impractical to provide the minimum sidewalk width, an accessible width of 900 mm must be maintained.

51-1.06 Stairs

Stairs shall not be part of an exterior accessible route or a sidewalk on public right of way because they cannot be safely negotiated by individuals in wheelchairs. Where stairs are used as part of an access route to a building or facility not subject to the ADA requirements, they should be designed to be accessible by other handicapped individuals. Therefore, the design of stairs must comply with Section 4.9 of the *ADA Guidelines*. This includes, for example, the provision of handrails. The designer should review the INDOT *Standard Drawings* for additional details on the design of stairs.

51-1.07 Ramps

Any part of an accessible route with a slope greater than 5% shall be considered a ramp and shall conform to the *ADA Guidelines*. This includes the provision of handrails. The following criteria must be met for ramps on accessible routes:

1. Slope and Rise. The least possible slope should be used for any ramp. Figure 51-1D, Allowable Ramp Dimensions (New Construction), provides the maximum allowable ramp slopes for new construction. Curb ramps and ramps to be constructed on existing sites or in existing buildings or facilities may have slopes and rises as shown in Figure 51-1E, Allowable Ramp Dimensions (Existing Sites, Buildings and Facilities), if space limitations prohibit the use of a 12:1 slope or less.

2. Width. The minimum clear width of a ramp shall be 0.9 m.

3. Landings. Ramps shall have level landings at the bottom and top of each run. Landings shall have the following features:

    a. The landing shall be at least as wide as the ramp run leading to it.

    b. The landing length shall be a minimum of 1.5 m clear.

    c. If ramps change direction at landings, the minimum landing size shall be 1.5 m by 1.5 m.

4. Handrails. If a ramp run has a rise greater than 150 mm or a horizontal projection greater than 1.8 m, then it shall have handrails on both sides. Handrails are not required on curb ramps. Handrails shall have the following features:

a. Handrails shall be provided along both sides of ramp segments. The inside handrail on switchback or dogleg ramps shall always be continuous.

b. If handrails are not continuous, they shall extend at least 300 mm beyond the top and bottom of the ramp segment and shall be parallel with the floor or ground surface.

c. The clear space between the handrail and the wall shall be 40 mm.

d. Gripping surfaces shall be continuous.

e. Top of handrail gripping surfaces shall be mounted between 860 mm and 960 mm above ramp surfaces.

f. Ends of handrails shall be either rounded or returned smoothly to floor, wall or post.

g. Handrails shall not rotate within their fittings.

5. Cross Slope and Surfaces. The cross slope of ramp surfaces shall be no greater than 2%. Ramp surfaces shall comply with the criteria for "Surface" for sidewalks (Section 51-1.05).

6. Edge Protection. Ramps and landings with dropoffs shall have curbs, walls, railings or projecting surfaces that prevent people from slipping off the ramp. Curbs shall be a minimum of 50 mm high.

7. Outdoor Conditions. Outdoor ramps and their approaches shall be designed so that water will not accumulate on walking surfaces.

51-1.08 Sidewalk Curb Ramps

Sidewalk curb ramps and other provisions for the physically impaired are required on all projects involving the provision of curbs and sidewalks at all pedestrian crosswalks. A pedestrian crosswalk is defined as the portion of a street ordinarily included within the prolongation or connections of lateral lines of sidewalks at intersections. It also includes any portion of a highway or street distinctly indicated as a crossing for pedestrians by lines or other markings on the surface.

A curb ramp provides a sloped area within a public sidewalk that allows pedestrians to accomplish a change from sidewalk level to street level. A curb ramp typically includes the ramp and flared sides and specific surface treatments, but does not include the landings at the top and bottom of the ramp.

51-1.08(01) Location

When determining the need for a curb ramp, the designer should consider the following:

1. For each project except signing, pavement marking, roadway lighting, and preventative maintenance paving, curb ramps are to be constructed at all crosswalks which extend from a paved sidewalk in an intersection. They are to be provided on all intersection corners with sidewalks. At T-intersections, the designer should ensure that curb ramps are located on the side opposite the minor intersecting road if a sidewalk is present or is to be provided. For a 4R or new construction project, curb ramps should be provided along all sidewalk corridors, e.g., at alleys and drives.

2. There should be full continuity of use throughout; i.e., opposing ramps should always be provided even if part of the sidewalk is outside the project limits.

3. Curb ramps should be located or protected to prevent their obstruction by parked vehicles.

4. Curb ramps should be located directly opposite one another for each crosswalk, and should be placed within the crosswalk lines.

5. A diagonal curb ramp should be wholly contained within the crosswalk lines, including any flared sides. There should be at least 1.2 m between the gutter line and the corner of the two intersecting crosswalk lines as delineated within the intersection pavement area. See Figure 51-1F, Types of Curb Ramps at Marked Crossings, for an illustration of these criteria.

6. The curb ramp and associated landings should not be compromised by other highway features (e.g., guardrail, catch basins, utility poles, signs, etc.). The ramp should be designed such that turning or maneuvering is not required on the ramp surface.

7. Curb ramps are required at all curbed intersections with connecting sidewalks. However, a Level One waiver of the Americans with Disabilities Act requirements request may be approved for locations where there are valid reasons to restrict or prohibit all pedestrian access.
8. The normal gutter flow line should be maintained through the curb ramp area. Appropriate drainage structures should be placed as needed to intercept the flow prior to the curb ramp area. Positive drainage should be provided to carry water away from the intersection of the curb ramp and the gutter line, thus minimizing the depth of any flow across the crosswalk.

51-1.08(02) Pedestrian Signal Controls

If a pedestrian crosswalk and curb ramp are present at an intersection with a traffic signal that has pedestrian detectors (pushbuttons), the following will apply.

1. Location. Controls should be located as close as practical to the curb ramp and, to the maximum extent feasible, should permit operation from a level area immediately adjacent to the controls. Controls should be placed so as not to create an obstruction to the curb ramp.

2. Surface. A sidewalk area of 1.2 m by 1.2 m should be provided to allow a forward or parallel approach to the controls. In a restricted area, such sidewalk area may be reduced to 0.9 m by 0.9 m.

51-1.08(03) Detectable Warning Devices

Most sidewalk curb ramps are to include detectable warning devices. These consist of a standardized surface feature to warn people with vision impairments that they are approaching a street or driveway. The color and texture of these devices contrast visually with adjoining surfaces. Details and explanations are shown in the INDOT *Standard Drawings* and *Standard Specifications,* respectively.

51-1.08(04) Types of Sidewalk Curb Ramps

Details for placement of curb ramps are shown on the INDOT *Standard Drawings*. Figure 51-1F is an illustration showing appropriate locations for all curb ramp types. Determining which curb ramp is most appropriate depends on the exact conditions of the site. Curb ramps are categorized below by their structural design and how they are positioned to the sidewalk or street.

1. Perpendicular Curb Ramp. This curb ramp is perpendicular to the curb and requires a wide enough sidewalk to provide a 12:1 running slope. The length of the ramp depends on the height of the curb where the ramp is to be located. Details of a ramp with an integral curb, and of a ramp with a separate curb are shown on the INDOT *Standard Drawings*. A landing should be provided at the top of the ramp. If site infeasibility precludes construction as shown on the INDOT *Standard Drawings*, the level landing width my be decreased from 1200 mm to 900 mm, and the running slope may be increased to 10:1 for a maximum 150 mm rise. If it is not possible to provide a level landing, a perpendicular curb ramp should not be specified. New construction should always provide adequate right of way for a perpendicular curb ramp. See the INDOT *Standard Drawings* for improved access to a perpendicular curb ramp.

A perpendicular curb ramp is the preferred curb ramp design. The standard perpendicular curb ramps are as follows:

a. Type A. This type should be specified where a curb ramp is required entirely within the pedestrian walkway.

b. Type C. This type should be specified where a curb ramp is required outside the pedestrian walkway, in the utility or planting strip.

c. Type D. This type should be specified where a curb ramp is required near an obstruction which can not be removed.

2. Diagonal Curb Ramp. A diagonal curb ramp is a single curb ramp that is located at the apex of the corner at an intersection, and serves two intersecting crossing directions. Since the ramp is diagonal to the path of travel, it is only accessible if level landing or maneuvering spaces are provided at both the top and bottom of the ramp. If creating a level landing is too difficult or a 1200 mm clear space cannot be provided, a diagonal curb ramp should not be considered. If site infeasibility precludes construction as shown on the INDOT *Standard Drawings*, the landing width may be decreased from 1200 mm to 900 mm and the running slope may be increased to 10:1 for a maximum 150 mm rise. Diagonal curb ramps should not be used in new construction. The standard diagonal curb ramps are as follows:

a. Type B. This type should be specified where a curb ramp is required entirely within the pedestrian walkway, and the corner radius is greater than 3 m. At the bottom of the ramp, the perimeter length is 2.4 m, regardless of the corner radius.

b. Type E. This type should be specified where a curb ramp is required outside the pedestrian walkway, in the utility or planting strip, and an obstruction which cannot be removed is present. This type should be specified where the corner radius is less than 7.5 m.

3. Parallel Curb Ramp. A parallel curb ramp has two ramps leading down towards a center level landing at the bottom between both ramps and has level landings at the top of each ramp. A parallel curb ramp may be specified for a narrow sidewalk, steep terrain, or at locations with a high curb, as the ramp can easily be lengthened to reduce the grades. A parallel curb ramp should not be installed where it is possible to install two perpendicular curb ramps. A wall or curb may be required along the back edge of the ramp as shown on the INDOT *Standard Drawings*. The designer should show details for such wall or curb on the plans and include a unique special provision. The standard parallel curb ramps are as follows:

a. Type F. This type should be specified where the corner radius is less than 7.5 m.

b. Type K. This type should be specified at a mid-block location. It may be used where the sidewalk is adjacent to the curb or where the sidewalk is separated from the curb by a buffer strip.

4. Depressed-Corners Curb Ramp. Depressed corners gradually lower the level of the sidewalk to meet the grade of the street or driveway. This curb ramp should be specified at a corner where the sidewalk is in one direction only. The standard depressed-corners curb ramps are as follows:

a. Type G. This type should be specified where a curb ramp is required outside the pedestrian walkway, in the utility or planting strip, and the sidewalk is separated from the curb.

b. Type H. This type should be specified where a curb ramp is required entirely within the pedestrian walkway.

5. Median Curb Ramp, Type L. This type should be specified where a raised median of 2.4 m or greater width obstructs the crosswalk. Where the median width is less than 2.4 m, a detail should be shown on the plans.

51-1.08(05) Selection

The following provides several suggestions for selecting the appropriate curb ramp.

1. Crosswalk Markings and Stop Lines. The placement of curb ramps affects the placement of pedestrian crosswalk and vehicle stop lines. Conversely, the location of existing crosswalk and stop lines affect the placement of curb ramps. Some of the crosswalk-line constraints are shown in Figure 51-1F, Types of Curb Ramps at Marked Crossings, and in the INDOT *Standard Drawings*. The *Manual on Uniform Traffic Control Devices* contains additional constraints on crosswalk- and stop-line placement.

2. Obstructions. It is desirable to move the obstruction wherever practical. Where it is not practical to move the obstruction, the direction of traffic relative to the placement of the curb ramp should be considered. It is important that drivers can see the physically impaired person using the curb ramp. Where obstructions are present, such as signal controller boxes, planters, signal pole bases, etc., a curb ramp type D or E may be used. No obstruction should be permitted within the paved flared sides of a curb ramp.

3. Sidewalk and Buffer Strip Widths. The INDOT *Standard Drawings* show minimum sidewalk widths and buffer strip widths. These minimum widths are intended for new construction and reconstruction. Curb ramp types F and K may be used where an existing sidewalk cannot be widened to the minimum width.

4. Diagonal Curb Ramps. The usage of diagonal curb ramp types B, E, and F should be avoided wherever practical. It is preferable to use another type of curb ramp or combination of ramps rather than to use a diagonal curb ramp. Curb ramp types B, E, or F should only be specified if a field investigation warrants their use for alterations affecting existing sidewalks. Specific constraints for crosswalk markings and stop line placement are shown in the INDOT *Standard Drawings*.

5. Best Practices. The following should be considered.

   a. A level maneuvering area or landing should be provided at the top of each curb ramp.
   b. The ramp slope should be perpendicular to the curb, at 7.1 $\pm$ 1.2%, with a maximum of 8.33%. Details regarding curb ramp slopes are shown in Figure 51-1D, Allowable Ramp Dimensions (New Construction).

   c. The ramp and gutter cross slope should be 2%.

51-1.08(06) Curb Ramp Lengths and Slopes

Curb ramps should be designed with a maximum slope of 12:1, or 8.33%. See Figure 51-1G, Lengths of Perpendicular Curb Ramps, to determine the length of a curb ramp which is perpendicular to the curb. The figure assumes a 2% sidewalk cross slope and a level longitudinal grade.

For a curb ramp which is not perpendicular to the curb, the following formula should be used to determine its length. The formula assumes a 2% sidewalk cross slope and a level longitudinal grade.

$$L_{CR} = \frac{h}{\cos\theta\left(G_R - G_S\right)} \qquad \text{[Equation 51-1.1]}$$

Where:

L_{CR} = Curb ramp length, m

H = Change in elevation, m

G_R = Curb ramp grade, % / 100

G_S = Sidewalk cross grade, % / 100

θ = Angle to which the curb ramp is out of perpendicular to the curb

51-1.08(07) Algebraic Difference Between Curb Ramp and Gutter Slopes

The algebraic difference between a curb ramp slope and the gutter or pavement slope should be less than 11%. If this is not possible, a 0.6-m wide level strip should be provided between the grades. See the INDOT Standard Drawings.

$$\Delta G = |GR - GG| \qquad \text{[Equation 51-1.2]}$$

Where:

Δ G = Algebraic grade difference, %

G_R = Ramp grade, %

G_G = Gutter grade, %

$|G_R - G_G|$ = Absolute value of grade difference, %

A level strip is required if $\Delta G \geq 11\%$.

51-1.08(08) Pay Limits and Pay Quantities

The pay limits for curb ramps are shown on the INDOT *Standard Drawings*. Quantities for curb or curb and gutter within the curb ramp limits should be incorporated into the project's appropriate curb or curb-and-gutter quantities. Quantities for sidewalk required outside the curb ramp pay limits, including those for additional landing area, should be incorporated into the project concrete sidewalk quantities. If flared sides are sod instead of concrete, such sodding should be incorporated into the project sodding quantities.

51-2.0 REST AREAS

Rest areas, information centers and scenic overlooks are functional and desirable elements of the complete highway development and are provided for the safety and convenience of the highway user. Many have been constructed along freeways and other major arterials in Indiana. The location and design of rest areas are based on individual highway facility and site needs. The need for a new rest area will be determined by the Environment, Planning and Engineering Division in conjunction with the district offices.

51-2.01 Location

Rest areas may be located on freeways or other major arterials. Along freeways, they are usually paired together (i.e., one on each side of the freeway). At the State line, only one rest area or welcome center for the incoming traffic may be provided. The following sections provide additional information in determining the need and location of rest areas.

51-2.01(01) Spacing (Interstates)

The recommended average spacing of rest areas on rural Interstates is approximately one hour of driving time or 80 km to 100 km. In some cases, it may be desirable to provide closer spacings for special conditions (e.g., scenic views, information centers). Local conditions may warrant spacings which are greater than 80 km to 100 km (e.g., through major metropolitan areas).

51-2.01(02) Site Considerations

Once it has been determined that a rest area is required and the general area has been selected, the actual location of the rest area is selected based upon the following considerations:

1. Appeal. Rest areas are show places for out-of-state visitors to Indiana. If practical, they should be placed to take advantage of natural features (e.g., lakes, scenic views, points of special or historic interest).

2. Welcome Centers. It is desirable to locate rest areas close to the State line. These locations provide the opportunity to personally present information on the State of Indiana and local attractions. Other rest areas typically only provide information racks for literature distribution.
3. Geometrics. The site should be located away from any other interference, such as interchanges and bridges. Desirably, the rest area entrance should be at least 5 km from the nearest interchange.

4. Environmental. The site should be located or designed so that surface runoff or treatment plant discharges will not adversely affect streams, lakes, wetlands, etc.

5. Medians. Rest areas should not be located in the medians of multi-lane highways unless they can be serviced by right-hand exits and entrances.

6. Size. The rest area should be large enough to provide sufficient parking capacity, needed facilities, picnic and stretch areas and to retain existing landscaping features.

7. Right-of-Way. Right-of-way costs should be factored into the location decision. To allow for future expansion, a 40-year design life should be considered based on a straight-line traffic projection.

8. Topography. Rest areas should be located where the natural topography is favorable to their development.

9. Development. Rest areas should not be placed adjacent to or near areas zoned residential.

10. Emergency. The location choice should consider the proximity to emergency services.

11. Water/Sewer. The area should have an adequate water supply. Water availability should be determined during the site selection process prior to the development of plans. If commercial sanitary treatment plants are unavailable, the site must be large enough to provide for adequate sewage treatment facilities. Recreational vehicle dump facilities may be provided.
12. Other Utilities. Other utilities, such as telephone and electricity, should always be provided.

51-2.02 Design

The following sections present criteria which should be considered in the design of the rest area for new and reconstruction projects.

51-2.02(01) Exits and Entrances

The access to and from the rest area should be designed according to the criteria in Section 48-4.0 "Freeway/Ramp Junctions." Reverse curves should not be used. If deemed necessary, they should be designed in accordance with Section 43-3.07. Full-depth shoulders should be provided along both exit and entrance ramps to the ramp extremities (i.e., the ends of the ramp tapers).

Adequate signing and pavement markings must be provided for the rest area. These traffic control devices should be placed according to Part VII, the INDOT *Standard Drawings*, and the MUTCD.

51-2.02(02) Buffer Separation

The separation between the rest area facilities and the highway mainline should be wide enough to discourage individuals from stopping on the mainline and crossing over to the facilities. At a minimum, a 10-m buffer area should be provided between the mainline pavement and parking areas. A buffer separation of 50 m or more is preferable. Fencing should be provided in the buffer area between the ramps and should desirably be located beyond the mainline clear zone.

51-2.02(03) Rest Area Usage

Predicting the rest area usage is the key factor in determining the location and sizing of a rest area. The designer must first determine the proportion of mainline traffic that will be using the rest area. This determination is dependent upon numerous factors: rest area spacing, trip lengths, rest area locations, time of year, traffic composition, highway classification, etc. Desirably, the designer should use data from nearby and/or similar rest areas to estimate the expected traffic entering the rest area. In the absence of historical data, Figure 51-2A, Design Guide for Rest Area Facilities (Interstates and Freeways), and the following may be used.

1. Design Year. The typical design year for traffic projections should be 20 years.

2. Highway Characteristics. Rest areas on highways that pass though recreational or historic areas tend to have fewer trucks and a higher percentage of passenger cars and RVs with trailers. Where the general purpose of the highway is to move commercial traffic between cities, rest areas tend to have a higher truck usage.

3. Trip Length. On highways where the trip lengths are typically less than 150 km (e.g., between two major cities), there is a significant reduction in the proportion of the passing traffic using the facility.

4. Temporal Factors. In recreational areas, rest area usage commonly is the highest during summer weekends. During the day, passenger cars tend to make up a higher percentage of the rest area usage. At night, trucks and RVs tend to make up the higher percentage of rest area usage.

51-2.02(04) Parking

Rest area parking capacity depends upon the type of usage expected for the rest area. Figure 51-2A, Design Guide for Rest Area Facilities (Interstates and Freeways), provides the formula and other factors to consider when determining the appropriate design hourly volume for passenger cars, passenger cars with trailers and trucks. Consideration should be given to adding additional truck parking spaces if the rest area is located close to major delivery or distribution centers.

Parking areas for passenger cars and trucks should be separated from each other within the rest area. Desirably, this should be accomplished by providing separate parking areas on opposite sides of the building. However, a separator (e.g., curbing) or pavement markings may be used in restrictive locations. Figure 45-1B illustrates typical parking designs for passenger cars. Angular parking is preferred versus parallel parking because it requires less time to enter and exit.

Figure 51-2B illustrates a typical angle parking design for trucks and recreational vehicles. It should be noted that the design vehicle for angular truck parking is the WB-20 vehicle.

51-2.02(05) Pavement Design

Pavements for exit and entrance ramps, truck parking areas and truck connector roadways should be designed using a 350-mm portland cement concrete pavement on 75 mm of coarse aggregate No. 8 on 150 mm of compacted aggregate No. 53. Pavement areas used only by passenger cars may be designed using a 250-mm portland cement concrete pavement on 75 mm of coarse aggregate No. 8 on 150 mm of compacted aggregate No. 53.

51-2.02(06) Cross Slopes

All ramps and connector routes should have a 2% cross slope. Parking areas typically should be designed with a 2% cross slope. A 5% maximum grade may be used. If practical, handicapped parking areas should not exceed 1%.

51-2.02(07) Facilities

Rest areas typically provide a building with rest rooms and public information services, picnic tables and shelters, benches, sidewalks, drinking fountains and trash collectors. They may also include vending machines, provided the machines are accessible from outside of the building. The designer should ensure that sufficient facilities are available to accommodate the expected usage of the rest

area. Figure 51-2A, Design Guide for Rest Area Facilities (Interstates and Freeways), provides the recommended total number of comfort facilities. Figure 51-2C, Guidelines for Comfort Facilities, should be used to determine the recommended number and types of fixtures. Dual men/women facilities (minimum of 2 each) should be provided at each rest area location to allow for cleaning, maintenance, etc. The total number of fixtures should be divided equally between the rest rooms. If practical, the designer should also consider providing exclusive unisex rest rooms for handicapped individuals. The building should be adequately sized to provide 11.1 m^2 of floor area for each sanitary facility plus an additional 18.6 m^2 of floor space. The rest area building must meet all Indiana Department of Fire Prevention and Public Safety building codes.

51-2.02(08) Utilities

Where permanent facilities are provided, an adequate drinking-water supply, a wastewater disposal system, and a power supply will be required. These are required to bring the facilities into accordance with federal, Indiana Administrative Code (IAC), and Indiana Department of Environmental Management (IDEM) regulations, and local ordinances. Where practical, connection to existing wastewater treatment facilities and drinking-water supplies is the most desirable option.

A dedicated drinking-water treatment system will require a security system, ozone addition for deposition of iron, chlorine treatment, phosphate treatment, and backflow prevention to prevent contamination of the stored water and the water from the well. The drinking-water treatment system structure shall be placed at least 1.2 m horizontally clear of other structures. For a purchased-water system, automated chlorine testing and addition will also be required. Drinking-water treatment should otherwise be in accordance with IAC 327.

A dedicated wastewater disposal system will require a testing laboratory. Wastewater treatment units will require protection from exposure to direct sunlight, covers or other means that prevent animals, bird feces, or external debris from entering the system, and shelter or other means that keeps the wastewater temperature within a specified range. A standby electric generator, surge control tank with dissolved oxygen sensor, trash collection tank, fixed film media filters, sand filters, ultraviolet disinfection, diffusers, and a splitter box are also required. The wastewater disposal system trash collection tank shall be placed upstream of the surge control tank. Wastewater treatment should otherwise be in accordance with IAC 327 and 329.

A remote telemetry system will be required for the drinking-water and wastewater treatment facilities, lift stations, and at locations where the water is purchased.

As a minimum, the telemetry system should include the following:

1. A portable laptop computer for data access and system interaction, including an operator training manual.

2. The computer software shall be compatible with and be able to enter data onto IDEM's report forms. The forms are accessible through IDEM's web site, at www.in.gov/idem/water/publications/appsforms.html#Municipal.

3. The interaction shall include an alarm to alert the plant operator (when the operator is both on-site and off-site) when the system's conditions are not within the required parameter limits.

4. A digital flow monitor.

5. The interaction shall include the ability to automatically add treatment chemicals.

The designer should develop appropriate specifications and call for appropriate pay items for this additional work. The specifications should comply with the Ten State Standards requirements. The Environment, Planning and Engineering Division's Environmental Services Section will review and approve the specifications.

The IDEM is responsible for approval of the final wastewater treatment and drinking-water supply options.

Telephones are commonly also included. Proper lighting provides the patron an added sense of security and safety. Chapter Seventy-eight provides additional information on lighting design.

51-2.02(09) Landscaping

The rest area should be landscaped to take advantage of existing natural features and vegetation (see Section 51-8.0). Paths, sidewalks and architectural style should fit naturally into the existing surroundings. The designer should coordinate the landscaping plan with the Landscaping Unit. Desirably, a chain link fence should be used between the parking areas and the adjacent roadway to enhance pedestrian safety.

51-2.02(10) Accessibility for the Handicapped

All rest areas must be designed to properly accommodate physically handicapped individuals, including grounds, picnic areas, ramps to picnic areas, buildings, automatic door openers, sidewalk ramps and signage. The designer must realize that an accessible route is required between the truck and RV parking area to the rest area facilities. Section 51-1.0 provides the handicapped accessibility

criteria for exterior features within rest areas. The *ADA Accessibility Guidelines for Buildings and Facilities* provides the handicapped accessibility criteria for interior features.

51-3.0 WEIGH STATIONS

Truck weigh station installations are used to weigh trucks, to provide for vehicular safety inspection, and/or to provide a source of data for planning and research. The determination of the need for truck weigh stations is a combined effort of INDOT, the Indiana State Police, the Department of Revenue and the Bureau of Motor Vehicles.

51-3.01 Location

Indiana has adopted the Point-of-Entry concept for locating new weigh stations. In general, weigh stations are only located at or near State lines for inbound trucks on Interstate routes.

The actual selection of a truck weigh station site is controlled by right-of-way and by geometric and topographic features (i.e., at the crest of a hill). It is desirable to select a site in a location where there is adequate right-of-way and where geometric, topographic and environmental features lend themselves to the most economical development without undue site preparation and expense. The possibility of truck traffic circumventing the facility is also considered in locating the site of the weigh station.

51-3.02 Design

Figure 51-3A illustrates a typical truck weigh station design. In addition, the following should be considered.

1. Exit/Entrance Junctions. Desirably, the exits and entrances should be designed for large trucks. Section 48-4.0 provides design criteria for these elements, including truck acceleration and deceleration lengths.

2. Exit/Entrance Ramps. The minimum paved width is 8.5 m, including a 1.2-m left shoulder and a 2.4-m right shoulder. In addition, the shoulders should be designed with a full-depth pavement structure along both exit and entrance ramps to the ramp extremities (i.e., the ends of the ramp tapers). The cross slope will typically be 2% for the entire width, including shoulders.
3. Pavement Design. Pavements for ramps and scale areas should be designed using a 350 mm portland cement concrete pavement on a 100-mm of course aggregate No. 8 on 75 mm of

compacted aggregrate No. 53. Parking areas should have a 300 mm portland cement concrete pavement on a 100 mm of course aggregate No. 8 on 75 mm of compacted aggregate No. 53.

4. Geometrics. The weigh station area should be designed so that backing maneuvers are not required (e.g., pull-through parking). All pavement geometrics should be designed to accommodate off tracking for a WB-20 design vehicle (Indiana Design Vehicle).

5. Maximum Grade. Short upgrades of as much as 5% do not unduly interfere with truck and bus operations. Consequently, for new construction it is desirable to limit the maximum grade to 5%. Grades across weigh-in-motion scales must be 0% for 30 m before and after the weigh-in-motion scale.

6. Buffer Separation. There should be a 10-m minimum buffer strip between the weigh station facility and the mainline pavement. Wider separations are desirable.

7. Storage Length for Scales. There should be sufficient space to queue trucks waiting for the scales without backing up onto the mainline. This distance will be based on the number of trucks on the mainline, length of trucks, expected hours of operation and time required for actual weighing. For design considerations, the design vehicle can be assumed to be the WB-20 truck. With the rapid advance in research on scales (e.g., weigh-in-motion), the designer should check with the various Department Sections and/or other agencies to determine the most appropriate time factor.

8. Safety Inspection. Weigh stations will also be used by the Indiana State Police as safety inspection stations. Therefore, a separate inspection building will be required. This building should be designed to accommodate a total of two WB-20 design vehicles, one in each of the adjacent bays.

9. Violation Storage. A space should be provided to store trucks that are either overweight or which have failed the safety inspection. These areas should be designed to accommodate the WB-20 design vehicle. Figure 51-2A, Design Guide for Rest Area Facilities (Interstates and Freeways), provides the design criteria for a WB-20 angular truck storage area.

10. Traffic Control Devices. Adequate signing and pavement markings should be provided prior to and at the truck weigh station. These traffic control devices should be designed and placed according to the MUTCD and the INDOT *Standard Drawings*. In addition, the designer should contact the Design Division's Traffic Design Unit for the latest electronic designs for "Open / Closed" signs. Special signing will also be necessary for the internal traffic flow through the weigh station, such as at the weigh control area and the inspection building.
11. Lighting. Chapter Seventy-eight provides information on the design of lighting at truck

weigh stations.

12. Inspection Buildings. Inspection buildings should be designed for year-around use with sufficient space for computer operations, a service counter for permit issuances and emergency showers for hazardous material removal. The Inspection building should meet all local building codes and OSHA criteria.

13. Hazardous Materials. A 6000-L tank is required on site for the storage of hazardous materials from leaking or overflowing trucks. In addition, a detention basin with flow release controls is required to contain surface runoff from the parking areas.

14. Landscaping. The weigh station should be designed to minimize the effect on existing vegetation. The designer should also ensure that any new or existing plants will not affect the driver's sight distance to the weigh station or any critical point within the weigh station. Section 51-8.0 provides additional information on the Department's landscaping policies.

51-4.0 OFF-STREET PARKING

A proposed highway project may incorporate some form of off-street parking. Typical applications may include the following:

1. providing off-street parking to replace on-street parking which will be removed as part of a proposed project;

2. the construction of a park-and-ride lot for commuters; or

3. the construction of a new rest area or improvement to an existing rest area.

The following presents criteria specifically for off-street parking lots. Section 51-2.0 discusses rest areas.

51-4.01 Location (Park-and-Ride Lots)

The Environment, Engineering and Planning Division in conjunction with the districts generally determines the location of park-and-ride lots during the planning stage on most projects. However, the designer usually has some control over the best placement of the lot when considering layout details, entrance and exit locations and traffic flow patterns.

Park-and-ride lots should be located at strategic points where transfers can conveniently be made

from auto to carpooling or transit modes. Considerations that will affect the location of the parking facility are as follows:

1. Accessibility. The lot should be convenient to residential areas, bus and rail transit routes, and the major highways used by commuters.

2. Congestion. The location should precede any points of congestion on the major commuting highway to maximize its benefits.

3. Connections. There should be sufficient capacity on connections between the lot and the major commuting highway.

4. Design. The site location must be compatible with the design and construction of the lot. The designer must consider property costs, terrain, drainage, subgrade soil conditions, and available space in relation to the required lot size, visibility and access.

5. Land Use. The location of the lot should be consistent with the present and future adjacent land use. Visual and other impacts on surrounding areas should be considered. Where necessary, site sizing and design should allow for buffer landscaping to minimize the visual impact.

6. Size. The lot must be large enough to accommodate its expected usage. Studies by the Pre-Engineering and Environment Division will determine the size of the lot and will determine the number of bus-loading areas.

51-4.02 Layout

The following should be considered when laying out a park-and-ride facility.

1. Entrances and Exits. Entrances and exits should be located to have the least disruption to existing traffic (e.g., away from intersections) and still provide the maximum storage space. Combined entrances and exits should preferably be as close to mid-block as practical. Where entrances and exits are separated, the entrance should be on the "upstream" side of the traffic flow nearest the lot and the exit on the "downstream" side. There should be at least one exit and entrance for each 500 spaces in a lot.

   All entrances and exits should be designed as commercial driveways according to the design criteria presented in Chapter Forty-six. The typical design vehicle will be a BUS or SU.

2. Drop-off/Pick-up Zones. Drop-off and pick-up zones for buses and autos should be clearly

separated from each other and from parking areas to avoid as many internal traffic conflicts as possible. The bus loading/unloading zone should be serviced by the innermost parking lanes; i.e., this zone should be adjacent to the terminal loading/unloading area. Handicapped parking and the separate "kiss-and-ride" area should be serviced by the next closest parking lanes. The number of parking spaces for drop-off zones is typically between 20 and 60.

3. Traffic Circulation. Traffic circulation should be arranged to provide maximum visibility and minimum conflict between small vehicles (autos and taxis) and large vehicles (large vans and buses). Also, adequate maneuvering room must be provided for larger vehicles. A counter-clockwise circulation of one-way traffic is preferred. This allows vehicles to unload from the right side.

4. Pedestrian and Bicyclist Considerations. The designer should consider pedestrian and bicycle routes when laying out a park-and-ride lot. Entrance and exit points in areas with high pedestrian volumes should be avoided, if practical. Sidewalks should be provided between the parking areas and the modal transfer points.

   Crosswalks should be provided where necessary and clearly marked and signed. In high-volume lots, fencing may be warranted to channel pedestrians to appropriate crossing points. Crossings at major two-way traffic circulation lanes should have a refuge island separating the travel directions.

   A bicycle parking area should be provided with stalls that allow the use of locking devices. If a large volume of bicycle traffic is expected, a designated bicycle lane to and from the bicycle parking area should be provided.

5. Accessibility for Handicapped Individuals. Section 51-1.0 discusses the accessibility criteria for handicapped individuals, which also apply to park-and-ride lots.

51-4.03 Design Elements

The following elements should be considered in the design of a park-and-ride facility.

1. Parking Stall Dimensions. Parking dimensions vary with the angle at which the stall is arranged relative to the aisle. Figure 51-4A, Parking Stall Dimensions, provides the design dimensions for 2.7-m x 5.6-m parking stalls based on one-way circulation and angle parking. Typical stall widths (measured perpendicular to the vehicle when parked) range from 2.6 m to 2.9 m. The recommended minimum stall size for self-parking of long-term duration is 2.6 m. For higher turnover self-parking, a stall width of 2.7 m is recommended. Stall widths at supermarkets and other similar parking facilities, where large packages are prevalent, should

desirably be 2.9 m or even 3.0 m in width.

2. Bus Loading Areas. The bus loading and unloading areas should be designed to provide for continuous counter-clockwise circulation and for curb parking without backing maneuvers. The traffic lanes and the curb loading area should each be 3.6-m wide. Figure 51-4B provides criteria for the recommended lengths of bus loading areas.

3. Sidewalk Dimensions. All sidewalks should be at least 1.8-m wide. In loading areas, the width should be at least 3.6 m. The accessibility criteria for the handicapped must be met for all new lots (see Section 51-1.0).

4. Cross Slope. To provide proper drainage, the minimum cross slope on the parking lot should be 2%. As a maximum, the gradient should not exceed 5%.

   Desirably, the lot should be designed directing the runoff into existing drainage systems. If water impoundment cannot be avoided along pedestrian routes, bicycle routes and standing areas, drop inlets and underground drainage should be provided. In parking areas, drainage should be designed to avoid standing water. Part IV provides additional information for the proper hydraulic design of drainage elements.

5. Pavements. A typical pavement design for parking areas in a park-and-ride lot is 75 mm of bituminous concrete on 150 mm of aggregate base. For bus routes, the minimum pavement design should be 125 mm of bituminous concrete on 250 mm of aggregate base. For additional information on pavement designs, see Chapter Fifty-two.

6. Lighting. Desirably, the lot should be lighted for pedestrian safety and lot security. Chapter Seventy-eight provides information on the design of lighting for parking facilities.

7. Shelters. Pedestrian shelters are desirable when loading areas for buses and trains are provided. Their inclusion will be determined on a case-by-case basis. The shelter should provide approximately 0.5 m^2 of covered area per person. As a minimum, the shelter should provide lighting, benches and trash receptacles. Routing information signs and a telephone should also be considered. For handicapped accessibility requirements, see Section 51-1.0.

8. Fencing. The need for fencing around a parking lot will be determined on a case-by-case basis.
9. Signs. Signs should be provided to direct drivers and pedestrians to appropriate loading zones, parking areas, bicycle facilities, handicapped parking and entrances and exits.

10. Landscaping. In some locations, landscaping may be provided to minimize the visual impact of the parking lot by providing a buffer zone around the perimeter of the lot or to improve the aesthetics of the lot itself. Desirably, space will be provided for a 3-m to 6-m buffer zone

around the lot to accommodate vegetation screens. Also, traffic islands and parking lot separators provide suitable locations for shrubs and trees. Landscaping should include low maintenance vegetation which does not cause visibility or security problems. For information on appropriate vegetation selections, the designer should contact the Landscaping Unit.

51-4.04 Maintenance Considerations

Maintenance of the commuter lot should be considered in design, including the following:

1. A 3-m to 6-m snow shelf should be provided around the perimeter of the lot, at least on two sides, to provide storage space during snow removal. This area can coincide with the buffer zone around the lot, provided that the entire area is not filled with shrubs or trees. Any fencing should be placed outside the snow shelf.

2. Raised traffic islands should be kept to a minimum; raised corrugated islands are preferred.

51-5.0 BUS STOPS AND BUS TURNOUTS

51-5.01 Location

51-5.01(01) Bus Stops

If local bus routes are located on an urban or suburban highway, the designer should consider their impact on normal traffic operations. The stop-and-go pattern of local buses will disrupt traffic flow, but certain measures can minimize this disruption. The location of bus stops is particularly important. These are determined not only by convenience to patrons but also by the design and operational characteristics of the highway and the roadside environment. If the bus must make a left-turn, for example, a bus stop should not be located in the block preceding the left turn. Common bus stop locations are shown in Figure 51-5A, On-Street Bus Stops.

Some considerations in selecting an appropriate bus-stop location are as follows:

1. Far-Side Stops. The far side of at-grade intersections is generally superior to near-side or mid-block bus stops. Far-side stops produce less impediment to through and right-turning traffic; they do not interfere as much with corner sight distance; and they lend themselves better to bus turnouts.

2. Mid-Block Stops. Mid-block bus stops may be advantageous where the distance between intersections is large or where there is a fairly heavy and continuous transit demand throughout the block. They may be desirable if there is a high bus stop demand located mid-block. Mid-block bus stops may also be considered when right turns at an intersection are high (250 in peak hour) and far-side stops are not practical.

3. Near-Side Stops. Near-side stops allow easier vehicle re-entry into the traffic stream where curb parking is allowed. At intersections where there is a high volume of right-turning vehicles, near-side stops can result in traffic conflicts and should be avoided. However, near-side stops must be used where the bus will make a right turn at the intersection.

51-1.01(02) Bus Turnouts

Interference between buses and other traffic can be reduced significantly by providing bus turnouts. Turnouts help remove stopped buses from the through lanes and provide a well-defined user area for bus stops. Turnouts should be considered under the following conditions.

1. The street provides arterial service with high traffic speeds and volumes and high-volume bus patronage.

2. Right-of-way width is sufficient to prevent adverse impact on sidewalk pedestrian movements.
3. Where curb parking is permitted but is prohibited during peak hours.

4. During peak-hour traffic, where there are at least 500 vehicles per hour in the curb lane.

5. Bus volumes do not justify an exclusive bus lane, but there are at least 100 buses per day and at least 10 to 15 buses during the peak hour.

6. The average bus dwell time generally exceeds 10 seconds per stop.

7. At locations where specially equipped buses are used to load and unload handicapped individuals.

51-5.01(03) Selection

The Pre-Engineering and Environment Division, in conjunction with the District Offices and the local transit agency, will generally determine the location of the bus stop or bus turnout. However, the designer usually has some control over the best placement of a bus stop or turnout location when

considering layout details, intersection design and traffic flow patterns.

51-5.02 Design

51-5.02(01) Bus Stops

Figure 51-5A provides the recommended distances for the prohibition of on-street parking near bus stops. Where articulated buses are expected to use these stops, an additional 6 m should be added to these distances. An additional 14 m of length should be provided for each additional bus expected to stop simultaneously at any given bus stop area. This allows for the length of the extra bus (12.2 m) plus 1.8 m between buses. Any changes in parking restrictions will require "Official Action" by INDOT.

51-5.02(02) Bus Turnouts

The following design criteria will apply.

1. The desirable width is 3.6 m; the minimum width is 3.0 m.

2. The full-width area of the turnout should be at least 15 m long. Where articulated buses are expected, the turnout should be 21 m. For a two-bus turnout, add 14 m.

3. Figure 51-5B illustrates the design details for bus turnouts. In the transition areas, an entering taper no sharper than 5:1 and a re-entry taper no sharper than 3:1 should be provided. As an alternative, short horizontal curves (30-m radius) may be used on the entry end and 15-m to 30-m curves on the re-entry end. When a turnout is located at a far-side or near-side location, the cross street area can be assumed to fulfill the need for the exit or entry area, whichever applies.

51-5.02(03) Bus Stop Pads

All new bus stops which are constructed for use with lifts or ramps must meet the handicapped accessibility criteria set forth in Section 51-1.0.

51-5.02(04) Shelters

The need for bus shelters, in general, will be determined by the Pre-Engineering and Environment Division in conjunction with the local transit agency. The designer should consider the following in the design of bus shelters.

1. Visibility. To enhance passenger safety, the shelter sides should provide the maximum transparency as practical. In addition, the shelter should not be placed such that it limits the general public's view of the shelter interior.

2. Selection. The local transit agency should be contacted to determine if they use a standardized shelter design.

3. Appearance. Shelters should be pleasing and blend with their surroundings. Shelters should also be clearly identified with "bus logo" symbols.

4. Handicapped Accessibility. New bus shelters must be designed to meet the accessibility criteria presented in Section 51-1.02.

5. Placement. The shelter should not be placed where it will restrict vehicular sight distance, pedestrian flow or handicapped accessibility. It should also be placed so that waste and debris are not allowed to accumulate around the shelter.

6. Responsibility. The local transit agency is responsible for providing and maintaining the shelter.
7. Capacity. The maximum shelter size is based upon the maximum expected passenger accumulation at a bus stop between bus runs. The designer can assume approximately 0.5 m^2 per person to determine the appropriate shelter size. See Section 51-1.02 for minimum handicapped accessibility requirements.

51-6.0 RECREATIONAL ROADS

Recreational road design criteria are applicable to roads on scenic drives and Department of Natural Resources properties such as State parks and other recreational areas. The objective for this type of facility is to provide a safe highway and still retain the aesthetic, ecological, environmental and cultural amenities of the area.

51-6.01 Functional Classification

Recreational roads can be divided into three functional classifications: primary access roads, circulation roads and area roads. Primary access roads provide access between the general public highways and the recreational facility. Circulation roads provide for the movement between activity sites within the recreational facility. Area roads allow for the direct access to individual activity areas such as ampgrounds, park areas, boat launching ramps, picnic areas, scenic overlooks and historic sites. Figure 51-6A illustrates a typical recreational road functional classification network.

51-6.02 Design

Strict adherence to highway criteria for these types of roads is usually inappropriate and unwarranted. Design speeds are usually low and driver expectancy is such that the reduction of design criteria does not produce serious safety concerns. Therefore, the designer should use engineering judgment to ensure that the design criteria fits the terrain and expected usage of the highway. Figure 51-6B provides the recommended geometric design criteria for recreational roads. However, for primary access roads which are a part of the county or State highway system, the geometric design criteria as presented in Chapter Fifty-three and Fifty-five for the appropriate functional classification should be used. In addition to Figure 51-6B, the designer should review the following sections.

51-6.02(01) Design Vehicle

Depending on the nature of the recreational area, the most common design vehicles may be a passenger car, passenger car with a travel trailer, passenger car with a boat trailer, motor home, a motor home with a boat trailer or, in some cases, buses. Where garbage pickup or other maintenance vehicles are required, an SU may be the most appropriate design vehicle.

The selected design vehicle should be used to determine lane widths, vertical clearances, intersection designs, etc.

51-6.02(02) Stopping Sight Distance

Figure 51-6B provides the minimum stopping sight distances for both 2-lane and 1-lane roads. On 2-directional 1-lane roads, sufficient sight distance must be provided to allow one vehicle to reach a turnout or for both vehicles to stop before colliding. This distance is considered to be twice the stopping sight distance.

51-6.02(03) Vertical Alignment

Figure 51-6B provides the recommended K-values for vertical curves, maximum grades and vertical clearances. Chapter Forty-four provides additional information on vertical alignment design.

51-6.02(04) Horizontal Alignment

For recreational roads, straight tangent sections are often aesthetically undesirable and often physically impractical. Figure 51-6B provides the recommended minimum radius based on an e_{max} of 4%. However, on some primary access roads, an e_{max} of 6% may be used. For very low design speeds (30 km/h or less) superelevation is often unnecessary and in many cases impractical. Chapter Forty-three provides additional information on horizontal alignment for paved roadways. Unpaved roadways are typically not superelevated.

On some narrow roadways with minimum radii, it may be necessary to provide travelway widening on the inside of sharp curves. AASHTO *A Policy on Geometric Design of Highways and Streets* provides information for the design of pavement widening. Typically, the design vehicle for pavement widening will be the motor home with a boat trailer (MH/B).

51-6.02(05) Cross Section

Figure 51-6B provides the recommended cross section widths for travel lanes, shoulders and auxiliary lanes. On recreational roads the use of wider pavements are often aesthetically objectionable and often unwarranted. The designer must balance the safety benefits of a wider roadway with those of aesthetic and environmental concerns.

Where traffic volumes are less than 100 vehicles per day, it may be feasible to use a 2-directional, 1-lane roadway. This roadway type is often desirable from an economic and environmental standpoint. Where 1-lane roadways with 2-directional traffic are used, turnouts for passing should be provided. Traffic convenience requires that such turnouts be intervisible, provided on all blind curves, and supplemented as necessary so that the maximum distance between turnouts is no more than 300 m. These turnouts should be a minimum of 3-m wide for a length of 15 m and should have a 10-m taper on each end. For extra-long or extra-wide vehicles, these dimensions may need to be adjusted.

Desirably on primary access roads, all foreslopes and backslopes will be 4:1 or flatter. However, on circulation and area roads this criteria is often aesthetically undesirable. At lower speeds, steep slopes typically do not present a problem. However, maintenance operations may be better facilitated by the use of flatter slopes. Ditch sections, typically a "V" ditch, should be deep enough to satisfactorily accommodate the expected design flow and provide for satisfactory drainage of the

pavement base and subbase.

51-6.02(06) Roadside Safety

Desirably, on the primary access roads an obstruction free zone of 3 m should be provided from the edge of the travel lane. However, use of smaller widths are often appropriate where economic or environmental concerns dictate. The use of an obstruction free zone on the lower class roads, circulation and area roads, is less critical due to their lower speeds and volumes. Nevertheless, the designer should provide as wide an obstruction free zone as practical where the accident potential is greater than normal (e.g., a sharp horizontal curve at the end of a long, steep downgrade). Section 55-5.0 provides additional information on the application of obstruction free zones.

Roadside barriers should only be installed at points of unusual danger. When barriers are installed, they should blend in naturally with the surrounding environment (e.g., wood rails on wood posts). For information on acceptable roadside barriers along recreational roads, the designer should contact the Indiana Department of Natural Resources' Engineering Division.

51-7.0 BIKEWAYS

The majority of bicycling will take place on public roads with no dedicated space for bicyclists. Bicyclists can be expected to ride on almost all roadways. Sometimes they use sidewalks as joint bicycle and pedestrian facilities, unless such usage is prohibited by local ordinance. This section primarily provides information on the development of new facilities to enhance and encourage safe bicycle travel.

51-7.01 Bikeway Classifications

The following bikeway definitions will apply.

1. Bikeway. Any road, path or way which in some manner is specifically designated as being open to bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or will be shared with other transportation modes.

2. Shared Roadway. Any roadway upon which a bicycle lane is not designated and which may be legally used by bicycles regardless of whether such facility is specifically designated as a bikeway.

3. Bicycle Path. A bikeway physically separated from motorized vehicular traffic by an open

space or barrier and either within the highway right-of-way or within an independent right-of-way. Bicycle paths may assume different forms, as conditions warrant. They may be 2-direction, multilane facilities or, where the path would parallel a roadway with limited right-of-way, a single lane on both sides of the road.

4. Bicycle Lane. A portion of a roadway which has been designated by striping, signing and pavement markings for the preferential or exclusive use of bicyclists. It is distinguished from the travel portion of the roadway by a physical or symbolic barrier. Bicycle lanes may also assume varying forms but are typically included in one of the following categories.

    a. bicycle lane between parking lane and travel lane, or

    b. bicycle lane between roadway edge and travel lane, where parking is prohibited.

51-7.02 Guidelines

Each type of facility has its own merits and disadvantages. Care must be exercised in choosing the appropriate type of facility for a given site. The following discussion and guidelines are offered to assist in making decisions regarding bikeway type. The use of definite, numerical limits for warrants should be avoided, and placing excess emphasis on any single concern should be avoided. Each route is unique and must be evaluated individually.

51-7.02(01) Bicycle Paths

Bicycle paths are normally constructed explicitly for use by bicycles. The cyclist is provided with a clear-cut route and is protected from many hazardous conflicts. However, bicycle paths are extremely expensive to construct due to right-of-way and construction costs.

The following guidelines may be used to justify a bicycle path.

1. high vehicular speed on adjacent roadway;

2. high vehicular traffic volume on adjacent roadway;

3. high percentage of trucks on the adjacent roadway;

4. high bicycle traffic volume;

5. substantial anticipated increase in vehicular and/or bicycle traffic volume;

6. absence of suitable alternative routes;

7. demonstration that the facility would serve a definite purpose; and

8. reasonable indication that the bicycle path would be the safest and most economical method of providing a bicycle facility.

51-7.02(02) Bicycle Lanes

The occupation of a portion of a roadway by a bicycle lane implies a reasonable degree of safety for the cyclist. Conditions must be generally less severe than those which recommend a bicycle path. The use of a bicycle lane is normally restricted to bicycles, but exceptions may be made. Some sort of physical or symbolic barrier must be employed to delineate the bicycle portion of the roadway. Commonly, this is a painted stripe on the roadway surface.

The cost of installing a bicycle lane is normally a fraction of the expense associated with bicycle paths. Another advantage of bicycle lanes is the relatively minor land requirements. They can be installed in many areas where the construction of paths would be impractical. In practice, bicycle lanes, although not ideal, may be the most practical means of developing bikeways.

The following guidelines may be used to justify a bicycle lane.

1. moderate to low vehicular speed on adjacent roadway;

2. moderate to low vehicular traffic volume on adjacent roadway;

3. moderate bicycle traffic volume;

4. anticipated increase in bicycle traffic volume;

5. insufficient land to construct bicycle paths without major disruptions on the surroundings;

6. demonstration that the facility would serve a definite purpose; and

7. indication that the bicycle lane would be the safest and only feasible method of providing a bicycle facility.

51-7.02(03) Shared Roadway

Mixing bicycles and motor vehicles should generally be avoided. There are instances, however, where this is a practical method of establishing a bikeway. Because a shared roadway is designated only by bikeway signs, it is implied that the roadway provides safe conditions for both cyclist and motorist. Where some type of bikeway is warranted, shared roadways should be allowed only where the existing conditions either do not justify the greater expense of a higher type facility or prevent their installation.
The following guidelines may be used to justify a shared roadway.

1. low vehicular speed on roadway;

2. low vehicular traffic on roadway;

3. low percentage of trucks on roadway;

4. moderate bicycle traffic volume;

5. anticipated increase in bicycle traffic volume;

6. demonstration that the facility would serve a definite purpose;

7. indication that the shared roadway would be the safest and only feasible method of providing a bicycle facility; and

8. a higher grade facility not warranted.

51-7.03 Selection

Local governmental agencies will generally determine the bikeway type and location for the bicycle facility during the planning stages on most projects. If during the design of a project, it is determined that a bicycle facility is required, the designer should coordinate with these agencies to determine the most appropriate bikeway type.

51-7.04 Design

For design criteria of bicycle facilities, the designer is referred to the AASHTO publication *Guide for the Development of Bicycle Facilities*.

51-8.0 LANDSCAPING

51-8.01 General

Roadside landscaping can greatly enhance the aesthetic value of a highway. Landscaping treatments should be considered early in project development so that they can be easily and inexpensively incorporated into the project design. This may require the acquisition of additional right-of-way to implement these treatments.

Landscaping treatments are typically not included with other project types, but are generally completed as a separate project. Landscaping treatments will be considered on a project-by-project assessment.

51-8.01(01) Responsibility

The Landscaping Unit within the Division of Design has the primary responsibility for determining or reviewing the landscaping treatment for road and bridge design projects. During the final field check on major projects, a landscape architect will typically attend the inspection to determine the landscaping treatment for the project. The Landscaping Unit or landscape consultant will submit recommendations and landscaping details to the designer for incorporation into the project design.

51-8.01(02) References

For information on landscaping procedures and plants, the designer should contact the Landscaping Unit for their expertise. In addition, the designer should review the INDOT *Standard Drawings*, the AASHTO *A Guide for Transportation Landscape and Environmental Design*, and the Landscaping Unit's reference library for more information on landscaping.

51-8.02 Benefits

Roadside landscaping can be designed advantageously to yield several benefits. The most important objective is to fit the highway naturally into the existing terrain. The existing landscape should be retained to the maximum extent practical. The following is a brief discussion of the benefits of proper landscaping.

1. Aesthetics. Gentle slopes, mountains, parks, bodies of water and vegetation have an obvious aesthetic appeal to the highway user. Landscaping techniques can be used effectively to enhance the view from the highway. In rural areas, the landscaping should be natural and should eliminate construction scars. The planting shape and spacing should be irregular to avoid a cosmetic appearance.

   In urban areas, the smaller details of the landscape predominate and plantings become more formal. The interaction between the occupants of slow-moving vehicles and pedestrians with the landscape determines the scale of the aesthetic details. In some cases, the designer may be able to provide walking areas, small parks, etc. Landscaping should be pleasant, neat and sometimes ornamental, and it should require low maintenance.

2. Erosion. Landscaping and erosion control are strongly interrelated. Flat and rounded slopes and vegetation serve to both prevent erosion and provide aesthetic value. Chapter Thirty-seven provides additional information on erosion control.

3. Maintenance. Landscaping decisions will greatly affect roadside maintenance. Maintenance activities for mowing, fertilizing and using herbicides should be considered when designing the roadside landscape. Involvement by other public or private groups (except on Interstate routes) should be encouraged to enhance the roadside landscape (e.g., Adopt-A-Highway Program).

4. Screening for Headlight Glare. Depending upon roadway alignment and the selected type of vegetation, landscaping features may be used to effectively screen headlight glare, for example, in freeway medians.

5. Screening for Noise Abatement. Although the effect may be more psychological than real, landscaping features may have some masking benefits to sensitive receptors.

6. Screening of Undesirable Views. Screening of junkyards and/or other undesirable views may be enhanced through the use of landscaping features.

7. Snow Drift. Landscaping features may assist in preventing snow from drifting and accumulating on the roadway.

51-8.03 Landscaping Considerations

All landscaping activities should be properly coordinated with other project design elements. The objectives are that other design elements should not be compromised by landscaping, and secondary benefits may be gained by the proper application of the landscaping features. Examples of

coordination between landscaping and project design are briefly discussed below.

1. Geometric Design. On new construction and reconstruction projects, the geometric design of the highway should be blended to fit the natural topography and landscaping features of the area. As practical, existing landscaping elements should be preserved and enhanced. The roadway alignment and cross section design should be compatible with the landscaping objectives. Special care needs to be given to ensure the landscaping treatment will not interfere with the driver's horizontal and intersection sight distance.

2. Roadside Safety. The introduction of landscaping features into the project should not compromise the objectives of roadside safety. Chapter Forty-nine presents the Department's criteria for roadside safety design. The most significant roadside safety element relative to the use of landscaping features is the clear zone concept. No roadside hazards should be located within the designated clear zones. All trees are considered a roadside hazard.

3. Environmental. Every effort should be made to use vegetation that will survive in the area with minimum maintenance. The selection of the vegetation will depend upon the soil conditions, drainage, amount of sun exposure, diseases and insects, road deicing chemicals, temperature and pollution.

4. Economics. Plant selection, availability, quantity and size greatly affect the cost of landscaping projects. Careful consideration should be provided in the selection of the plantings to provide a cost-effective design.

51-8.04 INDOT Landscaping Policies

51-8.04(01) Plant Establishment Policy

Projects which include plantings may have a special provision which requires the contractor to be responsible for a plant establishment period of at least one year. Longer establishment periods may be required where survival is considered essential to the function of the plantings (e.g., junkyard screening, urban landscaping).

51-8.04(02) Protection of Existing Vegetation

The Department's general policy is that, wherever practical, existing trees and other landscaping features will not be removed on highway projects. This objective, however, must be compatible with other considerations such as roadside safety, geometric design, utilities, terrain, public

acceptance and costs. The plans should clearly designate all existing landscape features which will be saved. If the existing plant material conflicts with these considerations, where applicable, the plant material should be evaluated by a landscape architect for possible relocation to a more suitable portion of the right-of-way.

51-8.04(03) Disturbed Areas

In areas disturbed by construction work, the designer should specify that the turf be reestablished. Turf establishment refers to the revegetation of disturbed areas. The designer should use the guidance in the following comments to determine the appropriate turf establishment, depending upon individual site conditions.

1. Topsoil. Topsoil is typically placed in disturbed areas to a depth of 150 mm or greater depending upon the underlying soil conditions.

2. Planting of Grass. All areas disturbed by construction, except exposed rock surfaces and areas to be sodded, will be seeded, fertilized and mulched.

3. Sodding. Where developed properties and/or areas of intensive mowing abut the highway project, all areas disturbed by construction should be sodded and watered sufficiently to establish growth.

The INDOT *Standard Specifications* and Chapter Seventeen provide additional details on turf establishment.

51-8.04(04) Wildlife Habitat Replacement

To some extent, most projects will disturb existing wildlife habitat. Wildlife habitats may include woodlands, overgrown fields and pastures and wetlands. The Department's policy is to replace any disturbed wetland. This will often require the purchase of additional right-of-way. To determine the project's effect on plants and animals, the designer should review the Design and Location Study Report or, where provided, the Environmental Impact Statement or Environmental Assessment. These reports may also provide recommendations on the type and quantities of habitat to be replaced.

The designer is responsible for incorporating the mitigation of the wildlife habitat into the road and bridge plans. This may include revegetation with special grasses and woody species, wetlands grading and seed mixtures, etc. However, wetlands revegetation with aquatic and woody species are usually administered by a separate contract once the road and bridge plans have been completed. The Environment, Engineering and Planning Division will assist in coordinating habitat types and

quantities. The Landscaping Unit will assist in the development of plans and specifications.

51-9.0 SOUND BARRIERS

Sound barriers are designed and erected to reduce the sound level of traffic adjacent to existing properties to an acceptable level as determined by Federal guidelines. Barriers are generally considered the most practical option to reduce sound when compared to other mitigating options (e.g., wider buffer zones, reducing speeds, eliminating or restricting traffic or vehicular types). The Environment, Planning and Engineering Division is responsible for determining the general longitudinal limits of the barrier, the lateral location from the roadway and the required height. The designer is responsible for the type selection, design of the sound barrier and evaluating the impacts of the sound barrier on the highway design and complying with the project intent of the Environment, Planning and Engineering Division.

51-9.01 Types

Several types of absorptive or reflective sound barriers are effective in reducing the environmental impact of noise from the highway. The following presents several sound barrier types that may be used.

1. Earth Berms. Earth berms are graded mounds of soil which redirect the highway sound from nearby sensitive areas.

2. Masonry Walls. Masonry walls are constructed from concrete blocks or bricks. Very pleasing architectural designs can be developed with this type of wall.

3. Concrete Walls. Concrete walls can be poured in place or precast. The advantage of concrete walls is that decorative designs can be added to the face of the wall.

4. Wood Walls. Wood walls are typically cheaper than masonry and concrete walls and are often preferred by residents. However, their life expectancy is typically less than masonry or concrete walls.

5. Metal Walls. Metal walls are constructed using galvanized or treated steel panels. Concerns relative to cost and corrosion have generally limited the use of steel walls.

6. Other Materials. New sound barrier materials are continuously being developed, such as recycled plastic, fiberglass, composites, etc. Prior to their use, they should be reviewed by the New Products Committee to ensure that will meet INDOT criteria.

7. Combination Walls. These walls use a combination of an earth berm and one of the other material types. Combination walls are often used to reduce the height of other wall types and for aesthetic purposes.

51-9.02 Design

The following presents several factors that should be considered in the design of a sound barrier.

1. Line of Sight. Noise waves generally travel in a straight line. Any barrier which breaks the line of sight between the source and receiver will provide some attenuation. For roadway sources, the line of sight is drawn perpendicular to the roadway. The sound source for cars and medium-sized trucks is assumed to be the roadway surface and, for large trucks, it is 2.4-m high. For the receiver, the line of sight is terminated at the expected ear height of the receiver (e.g., 1.5 m). The designer must also consider that the receiver may be in multi-storied buildings.

2. Structural Design. All sound barriers should either meet the criteria set forth in the AASHTO *Standard Specifications for Highway Bridges* or the AASHTO *Guide Specifications for Structural Design of Sound Barriers*. See Chapter Seventy-three.

3. Length. To block the roadway noise from the sides, the ends of the barrier should exceed the receiver by four times the distance from the barrier to the receiver; see Figure 51-9A, Sound Barrier Placement , detail (a).

4. Location. Moving the barrier closer to the receiver or source will generally increase the effectiveness of the barrier.

5. Gaps. Gaps in the barrier for pedestrian access, cross-streets or access for maintenance purposes can compromise the barrier performance. Where practical, the effects of theses gaps should be minimized by providing tight-fitting access doors, by curving the ends of the barrier to shield nearby receivers or by overlapping sections of barrier. Figure 51-9A detail (b) illustrates the minimum distance required to maintain the acoustical effectiveness of the wall for overlapping barriers.

6. Right-of-Way. Additional right-of-way may be required for the installation and maintenance of the sound barrier.

7. Roadside Safety. The following discusses several concerns the designer should consider relative to sound barriers and roadside safety.

a. Clear Zones. Section 49-2.0 provides the Department's design criteria for clear zones. If practical, sound barriers should be placed outside of the clear zone. If the barrier is within the clear zone, an integral concrete barrier shape or a metal barrier rail should be considered to shield run-off-the-road vehicles from the barrier.

b. Terminals. Sound barriers should be terminated outside the clear zone. However, if the end of the barrier is within the clear zone, the designer should consider protecting the end with guardrail or a appropriate impact attenuator. Section 49-6.0 discusses the design of impact attenuators.

c. Traversability. If the sound barrier is an earth berm, the toe of the barrier should be traversable by a run-off-the-road vehicle (see Section 49-3.02).

d. Protrusions. Protrusions on the barrier may become safety hazards if they are struck or are dislodged by a vehicle. Figure 51-9B, Sound Barrier Protrusions, illustrates the preferred practice for placing barrier protrusions and decorative facing.

8. Emergency Access. Where sound barriers are placed relatively close to the roadway (e.g., at the edge of shoulder), sufficient escape routes must be provided in the wall to allow individuals to quickly leave the roadway in the case of emergencies. These escape routes may be provided by inserting doors or overlapping walls. Item 5 above discusses the preferred methods for providing gaps in the barrier design. Where provided, access to fire hydrants should also be incorporated into the wall design.

9. Sight Distance. The designer should consider the following potential sight distance impacts relative to sound barriers:

a. At-Grade Intersections. Sound barriers should not be located in the triangle required for corner sight distance. Section 46-10.0 provides the criteria to determine the required sight distance triangle.

b. Entrance Ramps. A sound barrier should not block the line of sight between the vehicle on a ramp and the approaching vehicles on the major roadway. Therefore, sound barriers should not be located in the gore area between an entrance ramp and freeway mainline.

c. Horizontal Sight Distance. Sound barriers can also restrict sight distances along the inside of horizontal curves. Section 43-4.0 provides the criteria to determine the middle ordinate value which will yield the necessary sight distance. The location of the sound barrier should be outside this sight line.

10. Interference with Roadside Appurtenances. The proposed location of a sound barrier could interfere with proposed or existing roadside features, including signs, sign supports, utilities and luminaire facilities. The designer must determine if these features are in conflict with the sound barrier and must coordinate the design with the applicable INDOT Design Sections.

11. Sound Considerations. The noise reduction provided by a barrier depends upon the diffraction of sound over the top and flanking around the sides of the barrier, the transmission of sound through the barrier and the multiple reflection caused by double barriers. Some barrier types can absorb some of the sound energy. The contribution of this absorption depends on the barrier surface, shape and material type. Hard, smooth surfaces will generally reflect the noise off the wall. With barriers on both sides of the roadway, the designer also needs to consider the impact of the reflected noise on the receiver.

12. Drainage. Special consideration needs to be given to drainage along the sound barrier. This may be accomplished by leaving a gap on the bottom and backfilling with gravel, by providing a hinged flap, by providing a closed drainage system, etc. Special care must be provided to ensure that the barrier's acoustical design is maintained (i.e., no open holes are permitted in the wall).

13. Landscaping. Consideration should be given to providing landscaping treatments that will enhance the aesthetics and design of sound barriers. Plantings should be provided, where practical, both in front of and behind the barrier. Low maintenance plantings should be used behind the wall.

14. Aesthetics. Appearance plays a critical role in the acceptance of the sound barrier. The barrier should either be blended into the background or made aesthetically pleasing. Various types of materials, texture and color should be considered. Smooth surfaces are generally not recommended.

    Due to the size of sound barriers, the designer should strive to reduce the tunnel effect by using variations of form, wall types and surface treatments.

    From both a visual and safety standpoint, sound barriers should not begin or end abruptly. Desirably, they should be transitioned from the ground line to their full height. This can be accomplished by using earth berms, curving the wall back, sloping the wall downward or stepping the wall down.

15. Public Involvement. Early community participation in the selection of various sound barrier options is encouraged to ensure community acceptance of the wall.

16. Maintenance Considerations. The location and design of a sound barrier should reflect the following maintenance factors.

a. The sound barrier must be located so maintenance crews can easily access the wall for routine repairs.

b. The sound barrier should be constructed of materials that discourage vandalism (e.g., graffiti) and allow for easy cleaning. In general, the maintenance of barrier materials is less costly if unpainted surfaces such as weathering steel, concrete, pressure-treated wood, or naturally weathered cedar or redwood are used.

c. The sound barrier should be designed so that any damage can be easily repaired. The barrier materials should be commercially available to reduce the need for keeping large stocks of material on hand.

d. The sound barrier should be located so that other maintenance operations can be reasonably performed (e.g., mowing, light bulb replacement, sign cleaning, spraying). If the barrier is located near the shoulder, access for maintenance behind the walls should be provided from local streets or through overlapping gaps.

e. The sound barrier should be located so that it will not impact snow removal operations. Barriers located at the edge of the shoulder will require manual removal of snow from the roadway.

51-10.0 HAZARDOUS MATERIALS

Hazardous waste sites can impact all phases of highway activities, including project development, design, right-of-way, construction and maintenance. These impacts can increase costs and delay highway projects. Ownership of a site from which there has been a release, or a threat of a release of a hazardous substance may indicate liability whether the contamination is the result of the agency's actions or those of others.

51-10.01 Responsibility

The Environment, Planning and Engineering Division is responsible for ensuring that the initial site assessment is performed during the environmental stage of the project. If the initial site assessment and coordination with other agencies identifies the need for additional work, a consultant will be used to conduct a preliminary site assessment. The Design and Land Acquisition divisions will be provided with summaries and/or copies of the information gathered on hazardous waste by the Environment, Planning and Engineering Division, typically at the time of environmental approval.

If high levels of contamination have been detected, the Environment, Planning and Engineering Division will forward the initial site assessment and the preliminary site investigation to the appropriate section of the Indiana Department of Environmental Management (IDEM), and it will request that they become involved with the property owner to characterize the site and develop a remedial plan to clean the site. This will be concurrent with the development of the preliminary plans. The Environment, Planning and Engineering Division will monitor the progress of IDEM.

At the time of the preliminary field check, the Environment, Planning and Engineering Division should be able to inform both the Design and Land Acquisition divisions on the status of the efforts of IDEM. At this stage, decisions can be made for the site. This may include redesigning the project to avoid the site, considering various land acquisition strategies, or delaying or dropping the project from further development due to significant hazardous waste considerations.

51-10.02 Location

Hazardous materials can emerge almost anywhere. However, common possible locations include near abandoned or active storage tanks, oil lines, illegal dumping sites, abandoned chemical plants, service stations, paint companies, machine shops, metal processing plants, electronic facilities, dry cleaning establishments, old railroad yards, auto junkyards, landfills, or near bridges with lead base paints. Early indicators of contamination include ground water contamination of nearby wells, discarded barrels, soil discolorations, liquid discharges, odors, abnormalities in vegetation and extensive filling and regrading. If there is a reasonable chance a site may contain hazardous materials, the Environment, Planning and Engineering Division should be contacted to determine if detailed testing of the site is warranted. If hazardous materials are suspected on a property, no attempt should be made to enter the property until the site has been cleared by IDEM.

51-10.03 Cleanup

Once the hazardous material location is known, its location must be shown on the plans. In addition, if known, the type of contamination must also be provided. The specifications or special provisions should include detailed instructions on the procedures for removing the material and properly disposing of the wastes. For example, on bridges with lead-based paints, all waste materials from sand blasting will not be allowed into the air or onto the ground but, instead, must be collected and properly disposed.

Certain special cleanup sites and materials may require a specialist contractor to determine the location and size of the contaminated site and to provide for the proper removal and disposal of the contaminated materials. Often, the specialist contractor will be required to complete the clean up

prior to construction.

51-11.0 MAILBOXES

Mailboxes and newspaper tubes served by carriers in vehicles may constitute a safety hazard, depending upon the placement of the mailbox. Therefore, the designer should make every reasonable effort to replace all non-conforming mailboxes with designs that meet the criteria in the INDOT *Standard Drawings* and the AASHTO *A Guide for Erecting Mailboxes on Highways*. Removal and replacement of mailboxes can be a sensitive issue and should be reviewed with the postage patron prior to their removal or replacement.

51-11.01 Location

Mailboxes should be placed for maximum convenience to the patron, consistent with safety considerations for highway traffic, the carrier and the patron. Consideration should be given to the minimum walking distance in advance of the mailbox site and possible restrictions to corner sight distance at intersections and driveway entrances. New installations should, where feasible, be located on the far right side of an intersection with a public road or private driveway entrance.

Boxes should be placed only on the right-hand side of the highway in the direction of travel of the carrier, except on one-way streets where they may be placed on the left-hand side. It is undesirable to require pedestrian travel along the shoulder. However, this may be the preferred solution for distances up to 60 m when compared to the alternatives, such as constructing a turnout in a deep cut, placing a mailbox just beyond a sharp crest vertical curve (poor sight distance), or constructing two or more closely spaced turnouts.

Placing mailboxes along high-speed, high-volume highways should be avoided if other practical locations are available. Mailboxes should not be located where access is from the lanes of a freeway or where access, stopping or parking is otherwise prohibited by law or regulation. No mailbox should be at a location that would require a patron to cross the lanes of a divided highway to deposit or retrieve mail.

Placing a mail stop near an intersection will have an effect on the operation of the intersection. The nature and magnitude of this impact depends on traffic speeds and volumes on each of the intersecting roadways, the number of mailboxes at the stop, type of traffic control, how the stop is located relative to the traffic control, and the distance the stop is from the intersection. The INDOT *Standard Drawings* show possible locations of mail stops at a typical rural intersection.

Mailboxes should be located so that a vehicle stopped at a mailbox is clear of the adjacent traveled

way. An exception to this objective may be reasonable on low-volume, low-speed streets and roads. In general, however, a vehicle stopped at a mailbox should be clear of the travelway and, the higher the traffic volume or speed, the greater the clearance should be. Figure 51-11A provides suggested guidelines for the lateral placement of mailboxes.

It is also desirable to provide a turnout if a 3.0-m or wider useable shoulder is unavailable. The INDOT *Standard Drawings* provide additional details for the design of turnouts for mail stops.

51-11.02 Design

The INDOT *Standard Drawings* provide the design criteria for the proper placement and attachment of mailboxes. The designer should also consider the following:

1. Heights. Mailbox heights are usually located so that the bottom of the box is 1.0 m to 1.2 m above the mail stop surface.

2. Post. The maximum strength supports that should be used are nominal 100 mm x 100 mm or 115-mm diameter wood posts or 40-mm to 50-mm diameter standard galvanized steel pipe post, embedded 600 mm into the ground. The use of concrete anchors is not acceptable. Alternate mailbox posts as approved by the FHWA are permitted.

3. Multiple Mailboxes. To reduce the possibility of ramping, multiple mailboxes should be separated by a distance at least equal to three-fourths of their height above ground.

4. Neighborhood Delivery and Collection Box Units (NDCBU). NDCBU is a cluster of 8 to 16 locked boxes mounted on a pedestal or within a framework. These clusters can weigh between 45 kg to 90 kg and may be a roadside hazard. Consequently, they should be located outside the clear zone or only on low-speed curbed facilities. Normally, NDCBU are located in trailer parks, apartment complexes and new residential subdivisions.